Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Micro Rain Radar (MRR) NASA ACHIEVE IPHEx

Introduction

The GPM Ground Validation Micro Rain Radar (MRR) NASA ACHIEVE IPHEx dataset was gathered during the Global Precipitation Measurement (GPM) Ground Validation Integrated Precipitation and Hydrology Experiment (IPHEx) in North Carolina from May 1, 2014 through June 15, 2014. The dataset includes data from the MRR instrument, which is part of the NASA Goddard Space Flight Center (GSFC) ACHIEVE ground-based mobile laboratory. The MRR is a Biral/Metek 24 GHz (K-band) vertically oriented Frequency Modulated Continuous Wave (FM–CW) radar that measures Doppler spectra, radar reflectivity, Doppler velocity, drop size distribution, rain rate, liquid water content, and path integrated attenuation. Data files are available in ASCII 'ave' data format.

Notice:
Data for May 8, 2014 is missing due to the MRR instrument being relocated.

Citation

Tsay S., A. Loftus, and P. Pantina. 2015. GPM Ground Validation Micro Rain Radar (MRR) NASA ACHIEVE IPHEx [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/GPMGV/IPHEX/MRR/DATA201

Keywords:

NASA; GHRC; GPM GV; IPHEx,;ACHIEVE; North Carolina; radar, micro rain radar, Doppler radar; vertical velocity, drop size distribution, rainfall rate, attenuation, liquid water content;

Campaign

The GPM Ground Validation campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after launch on the GPM Core Satellite, which launched on February 27, 2014. The instrument validation effort included numerous GPM-specific and joint-agency/international external field campaigns, using state of the art

cloud and precipitation observational infrastructure (polarimetric radars, profilers, rain gauges, disdrometers). Surface rainfall was measured by very dense rain gauge and disdrometer networks at various field campaign sites. These field campaigns accounted for the majority of the effort and resources expended by the GPM Ground Validation mission. More information about the GPM Ground Validation mission is available at https://pmm.nasa.gov/index.php?q=science/ground-validation.

One of the GPM Ground Validation field campaigns was the GPM IPHEx, which was held in North Carolina during 2014 with an intense study period from May 1 to June 15, 2014. The goal of the IPHEx campaign was to contribute to the development, evaluation, and improvement of remote sensing precipitation algorithms in support of the GPM mission through NASA GPM Ground Validation field campaign (IPHEX_GVFC) and the evaluation of Quantitative Precipitation Estimation (QPE) products for hydrological forecasting and water resource applications in the Upper Tennessee, Catawba-Santee, Yadkin-Pee Dee, and Savannah river basins (IPHEX-HAP, H4SE). NOAA Hydrometeorology Testbed (HTM) has synergy with this project. More information about IPHEx is available at http://gpm.nsstc.nasa.gov/iphex/.

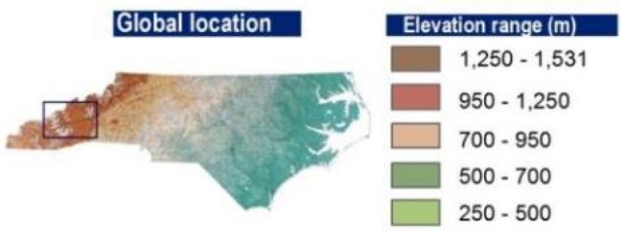

Figure 1: Region of North Carolina IPHEx campaign ground validation (image source: http://gpm-gv.gsfc.nasa.gov/Gauge/)

Instrument Description

The MRR instrument is a Biral/Metek 24 GHz (K-band) Micro Rain Radar. It is a vertically oriented microwave profiler that can measure drop size distribution in the range of 0.25mm to 4.53mm. This covers the size range of atmospheric precipitation drops as larger drops in the atmosphere are affected by the air resistance as they fall and will split into smaller drops. From the drop size distribution other parameters are derived such as rain rates, liquid water content, Doppler velocity of falling drops, and path integrated attenuation. During the IPHEx campaign, the MRR instrument was located near Maggie Valley, North Carolina, U.S.A.

More information about the MRR instrument is available at http://www.biral.com/product/micro-rain-radar/ and http://www.alliance-technologies.net/meteo/PARTENAIRES/METEK/pdf/MRR.pdf.

Figure 2: MRR used for GPM Ground Validation
(Image source: http://wallops-prf.gsfc.nasa.gov/Radar/MRR/index.html)

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File Naming Convention

The GPM Ground Validation Micro Rain Radar NASA Achieve dataset files are named with the following convention:

Data: IPHEx_ACHIEVE_MRR_YYYYMMDD_ave.txt

Table 1: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
ave.txt	ASCII format file containing averaged data

Data Format Description

The GPM Ground Validation Micro Rain Radar NASA ACHIEVE IPHEx data are available in ASCII format. Each file contains three header lines followed by the platform data.

The first header line contains the instrument name, date/time stamp, time zone information, device version number, device serial number, bandwidth, calibration constant, micro rain radar data quality (percentage of valid spectra), and identifier for data type. The second header line contains the height above the ground the measurement was taken in meters. The third header line contains the transfer function for each height step. Data lines follow the third header and start with the letter F and a 2-digit number representing the spectra line, and the data following represent the the spectral signal power for each height step in the engineering units received. The order of the data are given in Table 3. More detailed information about the MRR data file format is available at https://www.ncas.ac.uk/index.php/en/documents/amf/manuals/1030-mrr-user-manual/file.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground stations
Instrument	Biral/Metek 24 GHz K-band Micro Rain Radar (MRR)
Spatial Coverage	N: 35.562, S: 35.482, E: -83.044, W: -83.176
Spatial Resolution	primarily 50m range resolutions, total range resolution of 1.5km; some files have 200m range resolution, total range of 6.2km
Temporal Coverage	Start date: May 6, 2014 Stop date: June 15, 2014
Temporal Resolution	daily
Sampling Frequency	1 minute
Parameter	Radar Reflectivity, Doppler Velocity, Precipitation Rate, Drop Size Distribution
Processing Level	Level 1A, 1B, and 2

Data Parameters

The MRR measures the parameters listed in Table 3. The GPM Ground Validation MRR NASA ACHIEVE IPHEx data are in ASCII text format with each line consisting of one parameter with the data following three header lines. The identifiers used in the file and the order they appear are in Table 3. More information about MRR data parameters is

available at https://www.ncas.ac.uk/index.php/en/documents/amf/manuals/1030-mrr-user-manual/file.

Table 3: Data Fields

Identifier	Description	Unit
MRR	Header Line	N/A
H	Height Header Line	m
TF	Transfer Function Header Line	dimensionless
F*nn*	Spectral reflectivities	dB
D*nn*	Drop size	mm
N*nn*	Spectral drop densities	$m^{-3}mm^{-1}$
PIA	Path Integrated Attenuation	dB
Z	Radar Reflectivity	dBZ
z	Attenuated radar reflectivity	dBZ
RR	Rain Rate	$mm\ h^{-1}$
LWC	Liquid Water Contents	$g\ m^{-3}$
W	Fall velocity	$m\ s^{-1}$

Where *nn* = represents the levels of atmosphere from minimum height to maximum height
The drop size given is for the center of the size class

Quality Assessment

A description of the physical principles behind the operation of the MRR is provided in https://www.ncas.ac.uk/index.php/en/documents/amf/manuals/1029-mrr-operational-pronciples/file. This measurement capability has been in operation for decades and the MRR is known to derive very small rain rates accurately. Errors are presented in Gerhard et al., 2005. The droplet number concentration in each drop-diameter bin is derived from the backscatter intensity of each frequency bin and the relationship of the terminal falling velocity and drop size is exploited to remotely measure droplet size. At higher measurement frequencies of the radar there can be signal attenuation effects, but these are generally weak enough that they can be corrected.

Strong vertical winds can affect the data due to distortion of the measured reflectivity spectra. When strong vertical winds are present, the MRR instrument overestimates the amount of attenuation present causing inaccurate measurements. More information about data quality is available in Tridon et al., 2011.

References

Barros, A.P., W. Petersen, et al., 2014: NASA GPM-Ground Validation: Integrated Precipitation and Hydrology Experiment, 2014 Science Plan. NASA. Text. http://dx.doi.org/10.7924/G8CC0XMR.

Gerhard, P. B. Fischer, et al., 2005: Profiles of Raindrop Size Distributions as Retrieved by Microrain Radars, Journal of Applied Meteorology, 44, 1930-1949, http://journals.ametsoc.org/doi/pdf/10.1175/JAM2316.1.

Marks, David A. 2016. Integrated Precipitation Hydrology Experiment (IPHEx). Retreived from: http://wallops-prf.gsfc.nasa.gov/Field_Campaigns/IPHEx/index.html.

Tridon, F., J. Van Baelen, and Y. Pointin, 2011: Aliasing in Micro Rain Radar data due to strong vertical winds, Geophysical Research Letters, 38, L02804. http://dx.doi.org/10.1029/2010GL046018.

Contact Information

To order these data or for further information, please contact:

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